

Analysis of Summer Thunderstorms in Central Alabama Using the NASA Land Information System



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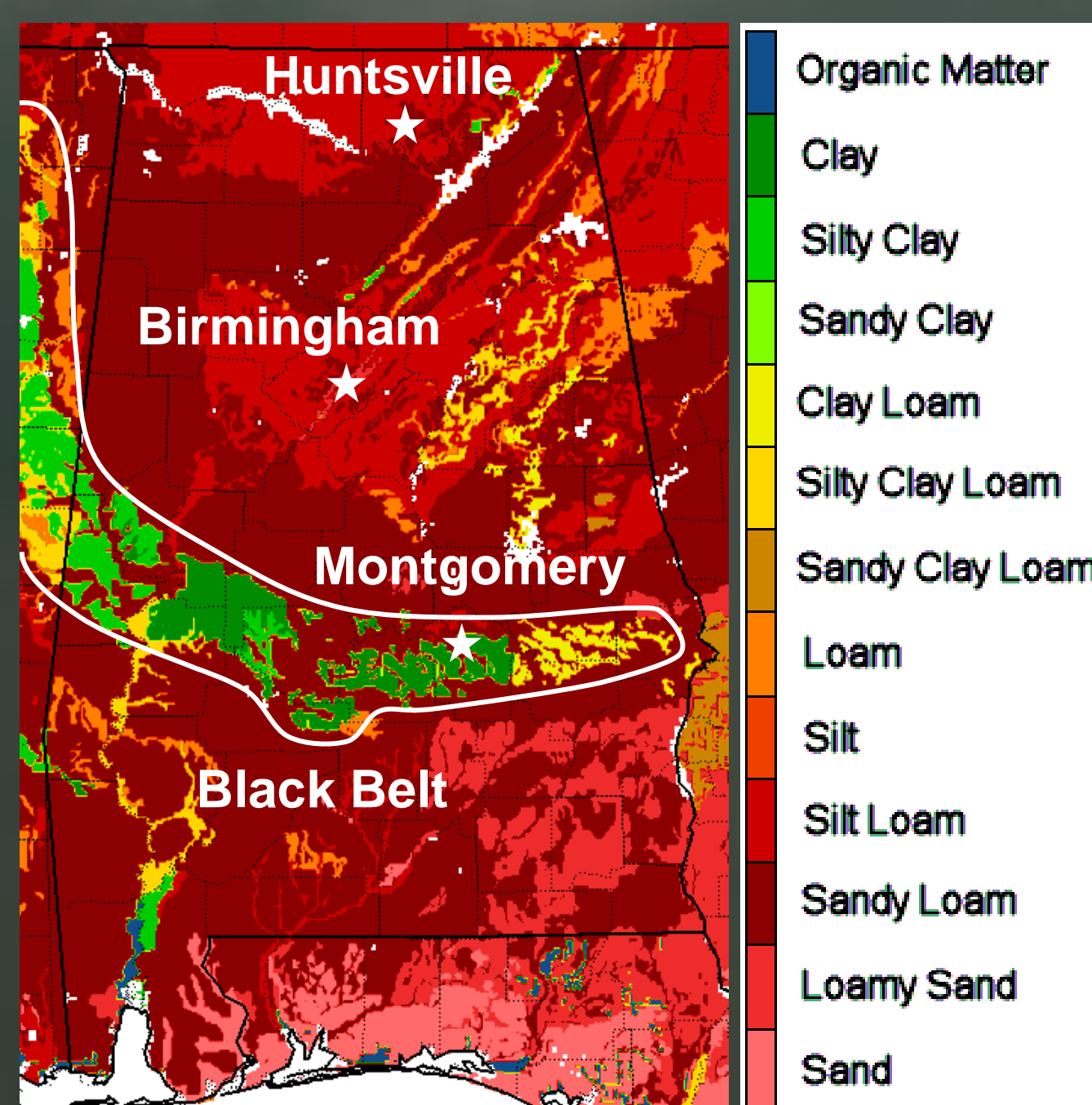
Introduction

- Forecasters have difficulty predicting “random” afternoon thunderstorms during the summer months.
- Differences in soil characteristics could be a contributing factor for storms.
- The NASA Land Information System (LIS) may assist forecasters in predicting summer convection by identifying boundaries in land characteristics.
- This project identified case dates during the summer of 2009 by analyzing synoptic weather maps, radar, and satellite data to look for weak atmospheric forcing and disorganized convective development.
- Boundaries in land characteristics that may have lead to convective initiation in central Alabama were then identified using LIS.

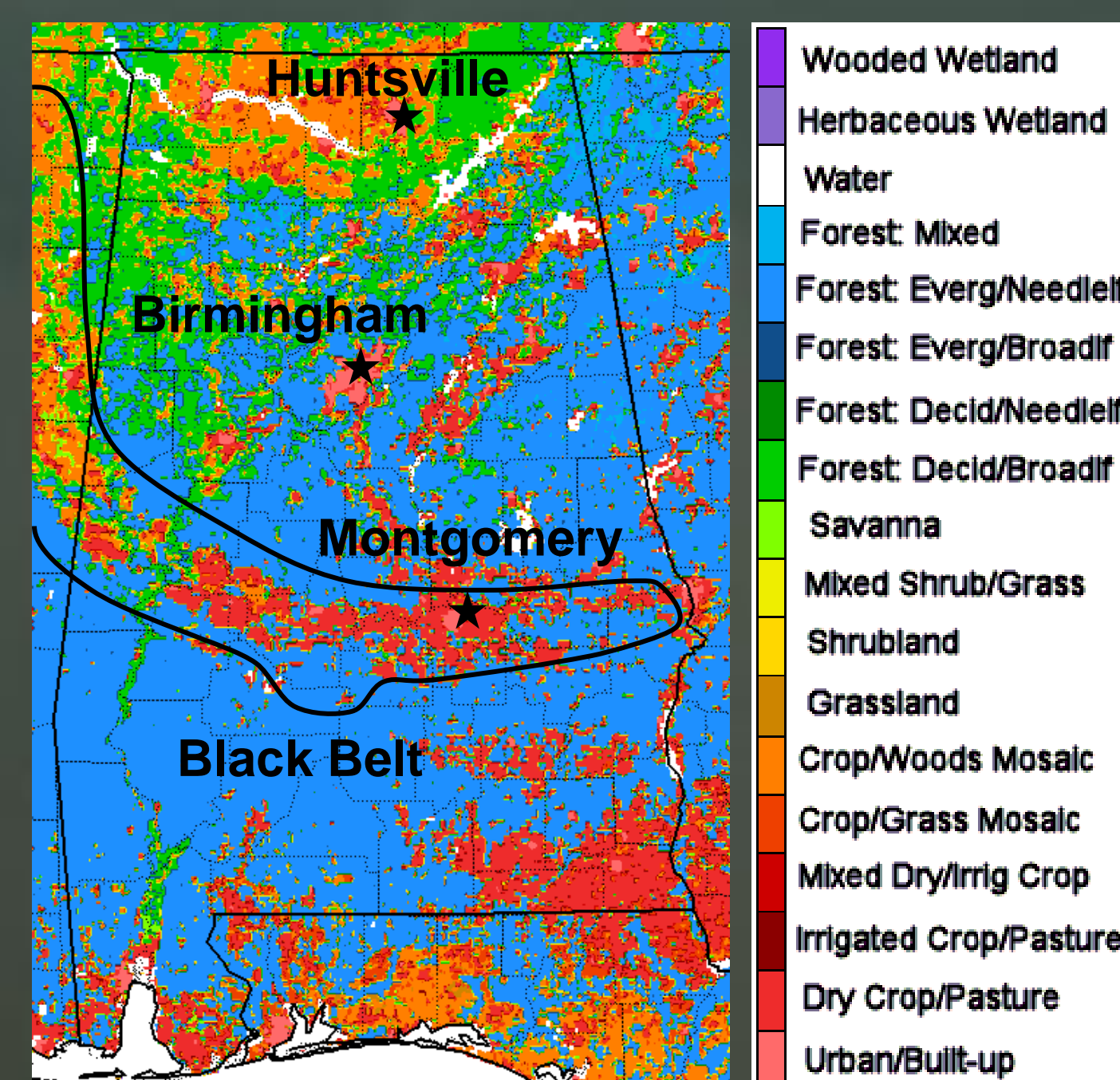
Background

- Alabama has a diverse selection of soil and vegetation types.
 - Clays, Sand, Silt, Loam; Forests, Grasslands, Crops
 - Black Belt located in southern Alabama (consists mostly of clay soils)
 - Urban areas (Birmingham, Huntsville, Montgomery, etc.)
- Soil and vegetation aid the transfer of moisture and energy into the atmosphere.
 - Increasing latent and sensible heat fluxes
 - Affect diurnal heating rates
- Thunderstorms can be initiated due to disparate or favorable heat fluxes from the surface.

Soil Type



Vegetation Type

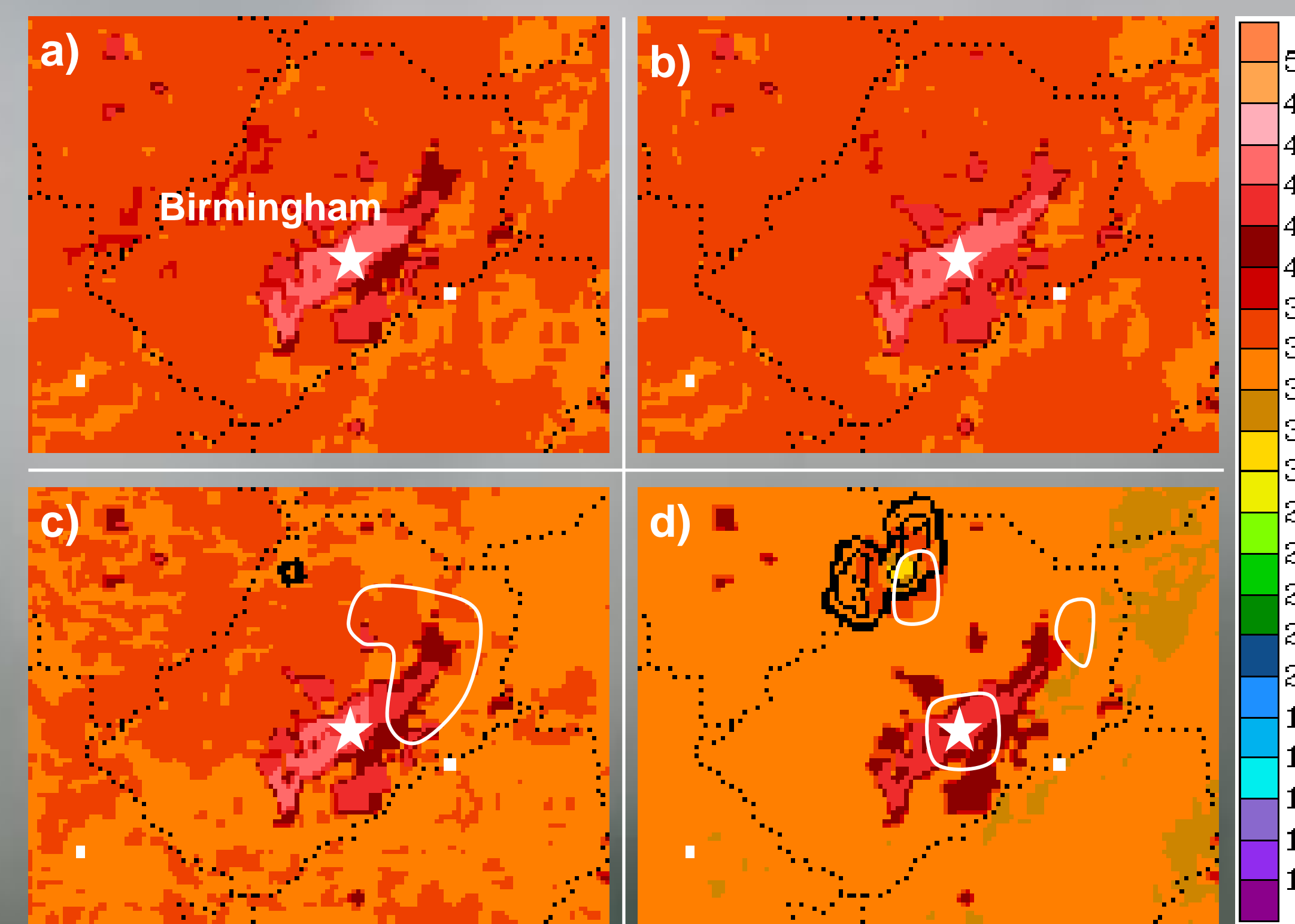


Conclusions and Future Work

- LIS shows the effect of increased sensible heat flux from “Urban Heat Islands” on downwind convection.
- Convection favored at skin temperatures $\geq 44^\circ\text{C}$
- Convection favored along gradients in land characteristics and surface fluxes as winds become perpendicular to these gradients.
 - Flow from lower to higher latent/sensible heat fluxes and skin temperatures
 - Differences in soil and vegetation types
- Continue study on convective initiation and correlations with land characteristics.
- Transition LIS model into operational forecasting to assist with short-term thunderstorm prediction.

1 June 2009

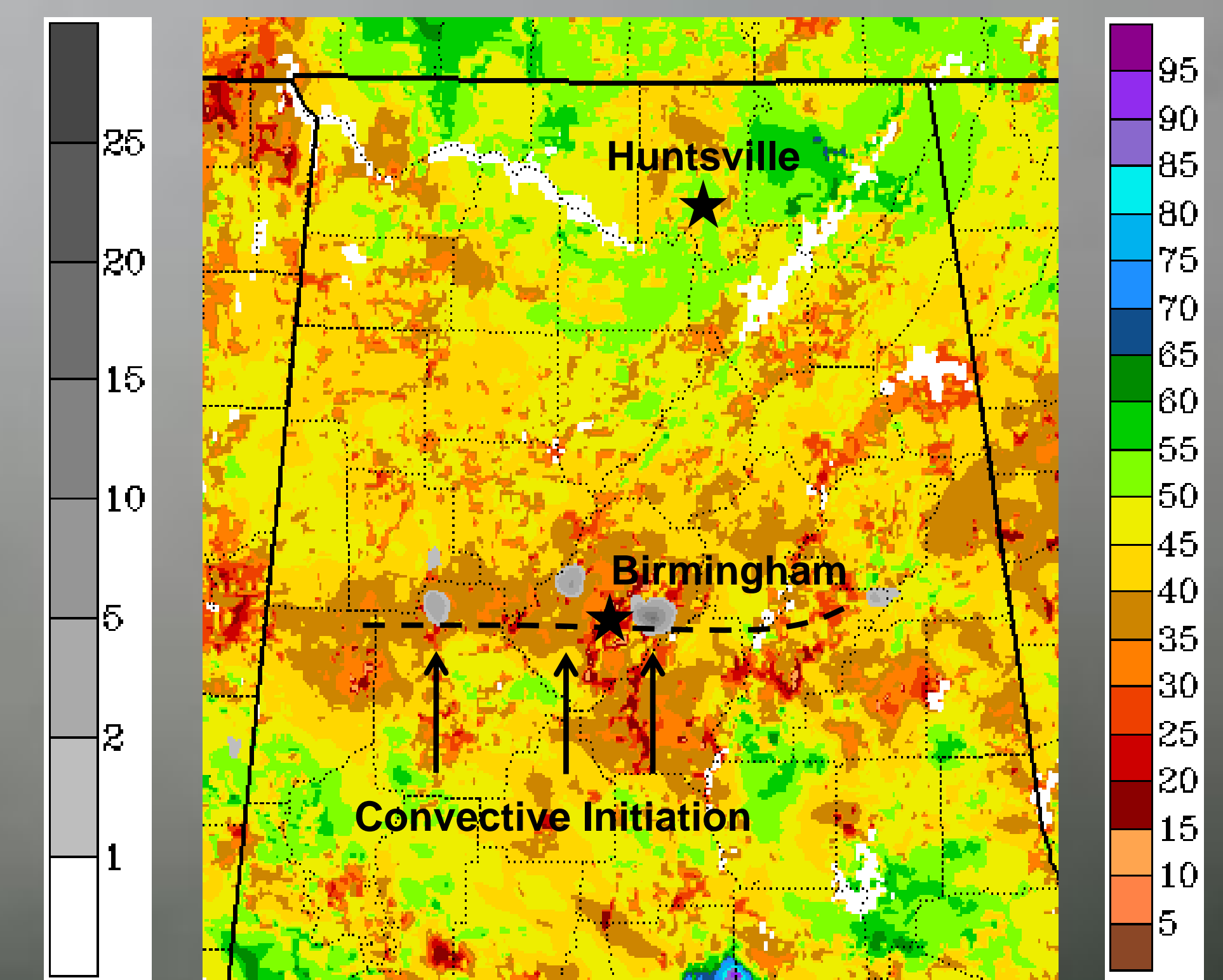
- Convection forms at 2015 UTC over Birmingham.
- Skin temperatures in Birmingham exceed 44°C .
- Sensible heat flux gradient around Birmingham.
 - Metro: $400\text{--}450\text{ W m}^{-2}$; Rural: $100\text{--}150\text{ W m}^{-2}$
- Storm forms downwind of Birmingham metro area.
 - Winds approaching from the southeast



Skin temperature (color shading, $^\circ\text{C}$), 20-dBZ contours (white), and accumulated rainfall ($> 1\text{ mm h}^{-1}$, black contours) valid at a) 1800, b) 1900, c) 2000, and d) 2100 UTC.

7 July 2009

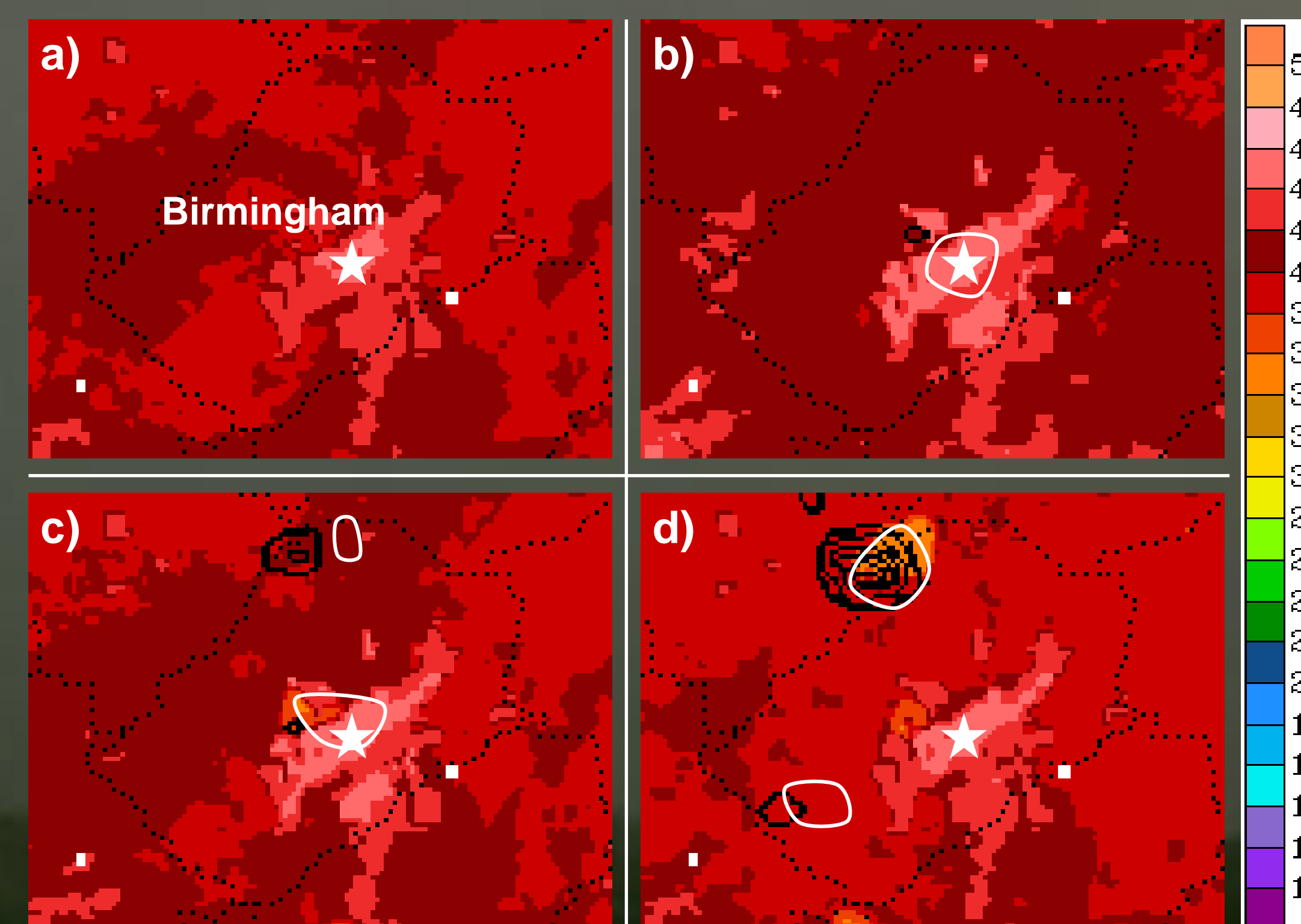
- Unknown boundary (indicated by dashed line) identified by forecasters at 2000 UTC across Birmingham.
- Significant area of drier soil along unknown boundary.
- Differences in heat fluxes may have lead to atmospheric forcing similar to sea-breeze circulations.
- Warm, dry soil acts as land; cool, wet soil acts as water.



0-10 cm relative soil moisture (% saturated) at 2000 UTC. Precipitation rate (gray shading) in mm h^{-1} .

14 August 2009

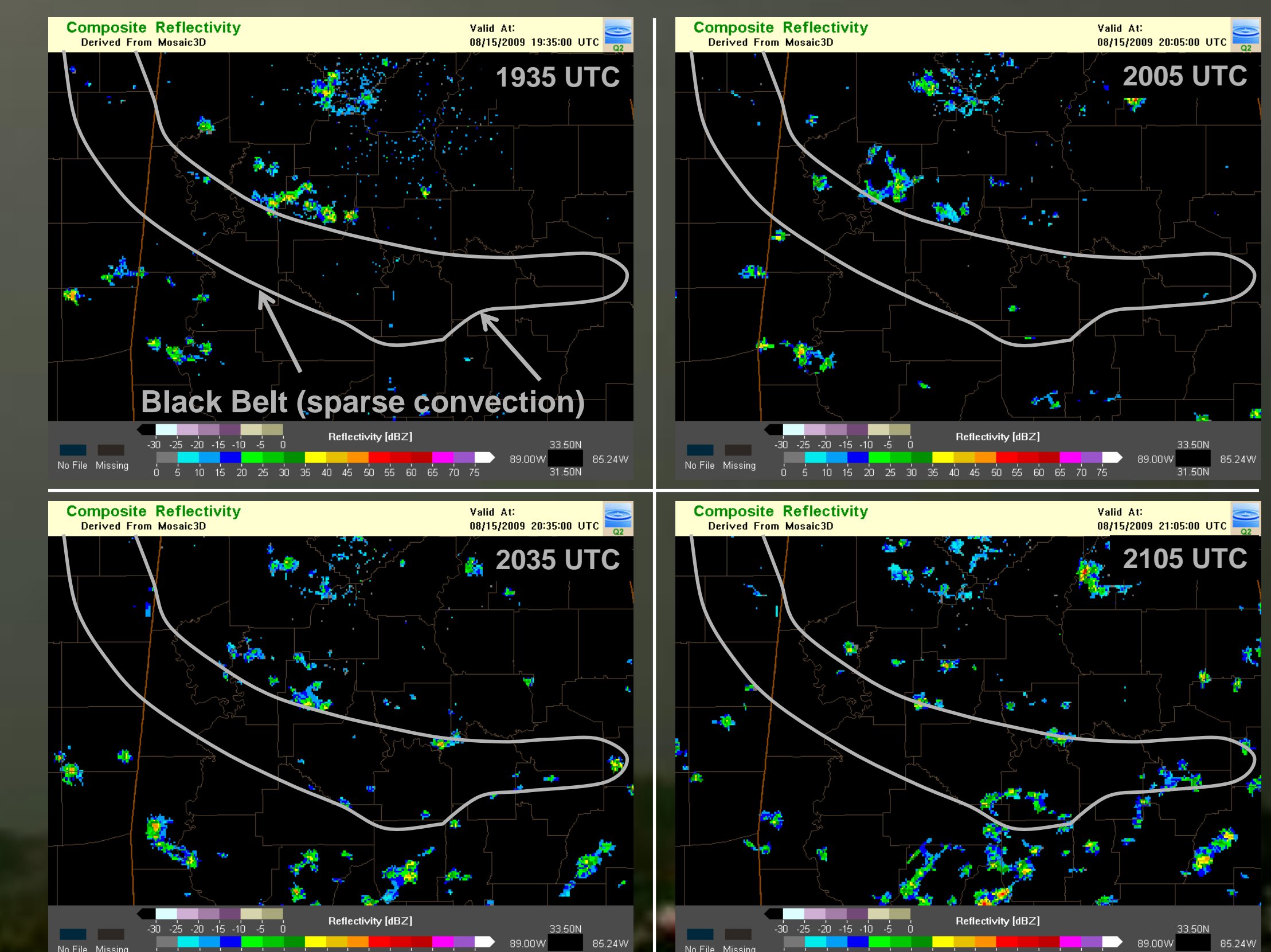
- Convection forms at 1800 UTC near Birmingham.
- Skin Temperatures between 44 and 46°C .
- Suburb areas reach higher skin temperatures than 1 June.
- High skin temperatures likely due to drier soil conditions.
- Southeasterly flow, storms form downwind of Birmingham.



Same shading and contours as 1 June 2009 graphics except valid on 14 August 2009 at (a) 1700, (b) 1800, (c) 1900, and (d) 2000 UTC.

15 August 2009

- Storms begin at 1800 UTC throughout central Alabama.
- Little convection occurs within the Black Belt.
- Limited amounts of latent heat flux due to dry soil.
- Convection forms and dissipates along boundary.
- Approximate Black Belt location indicated by gray line.



Images provided by the National Mosaic & Multi-sensor QPE Composite Radar Reflectivity.

Acknowledgements

- To the North Carolina Space Grant for providing funds for this research project and residence in Huntsville, AL for the summer of 2010.
- To the National Mosaic & Multi-sensor QPE Composite Radar Reflectivity for providing radar and satellite images of the summer of 2009.
- To Plymouth State University for providing an archive of surface and upper-air weather maps for the summer of 2009.
- To Jessica Showers for photographing and allowing the use of the background picture for this poster.